

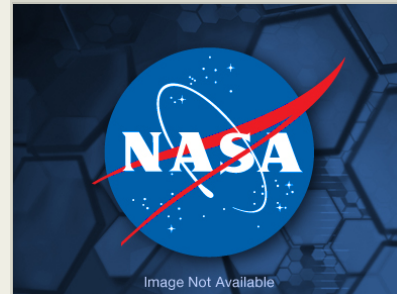
# A Balloon-Borne, Advanced Scintillator Compton Telescope with Silicon Photomultiplier Readout

Completed Technology Project (2015 - 2017)



## Project Introduction

We propose to continue our development of new medium-energy gamma-ray instrumentation by constructing and flying a balloon-borne Compton telescope using advanced scintillator materials combined with silicon photomultiplier readouts. There is an urgent need in high-energy astronomy for a medium-energy gamma-ray mission covering the energy range from 0.4 - 20 MeV to follow the success of the COMPTEL instrument on CGRO. Judging by the Astro2010 Decadal Survey and subsequent Physics of the Cosmos technology report, such a mission will have to fit within the Explorer Program, or be realizable using a series of ultra-long duration balloon (ULDB) flights, if it is to become reality in the foreseeable future. This in turn will require the use of relatively robust, low-cost, off-the-shelf technologies that can nonetheless achieve at least an order of magnitude improvement in sensitivity over COMPTEL. Fortunately, high-performance scintillators, such as Lanthanum Bromide (LaBr<sub>3</sub>), Cerium Bromide (CeBr<sub>3</sub>), and p-terphenyl, and compact readout devices, such as silicon photomultipliers (SiPMs), are already commercially available and capable of meeting this need. In previous work we have demonstrated that a Compton telescope consisting of an organic scintillator scattering layer and a LaBr<sub>3</sub> calorimeter effectively rejects background under balloon-flight conditions, using time-of-flight (ToF) discrimination. In separate work, we have shown that the combination of LaBr<sub>3</sub> scintillator with a SiPM readout performs well as a gamma-ray spectrometer, and that SiPM readouts can effectively perform pulse-shape discrimination (PSD) using organic scintillators such as stilbene. Finally, through the Gamma-Ray Polarimeter Experiment (GRAPE) balloon program we have flight-validated a balloon gondola suitable for ULDB missions, including rough pointing, aspect determination, and telemetry systems. We now propose to combine these efforts. We will construct an Advanced Scintillator Compton Telescope (ASCOT) with SiPM readout and fly it on an engineering balloon flight from Ft. Sumner, NM. The instrument will be of sufficient scale to image the Crab Nebula in a one-day flight. The results of this work will demonstrate conclusively that the energy, timing, and position resolution of this technology are sufficient to achieve an order of magnitude improvement in sensitivity in the medium-energy gamma-ray band, were it to be applied to a ~1 cubic meter instrument on a ULDB or Explorer platform. Such an instrument would be able to make groundbreaking gamma-ray measurements of bright relativistic particle accelerators, such as galactic black holes, pulsars, solar flares, and gamma-ray bursts.



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## Organizational Responsibility

### Responsible Mission Directorate:

Science Mission Directorate (SMD)

### Responsible Program:

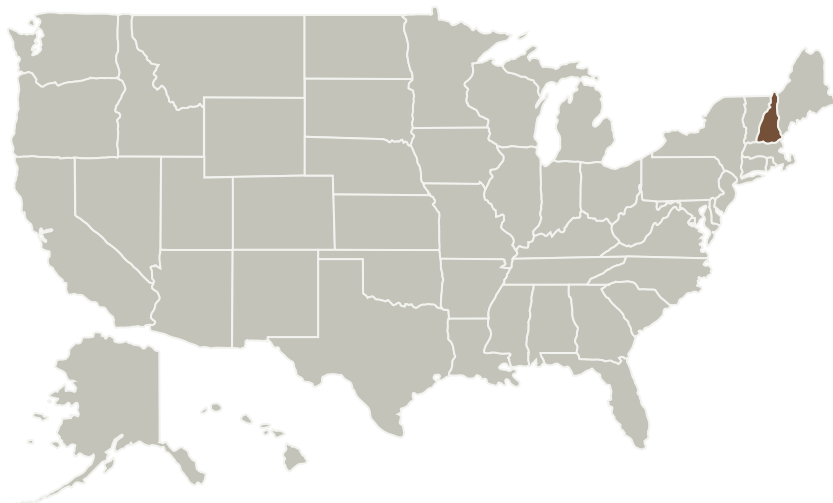
Astrophysics Research and Analysis

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## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Office of Sponsored Research and Programs - NC Central University	Supporting Organization	Academia	Durham, New Hampshire
University of New Hampshire-Main Campus	Supporting Organization	Academia	Durham, New Hampshire

## Primary U.S. Work Locations

New Hampshire

## Project Management

**Program Director:**

Michael A Garcia

**Program Manager:**

Dominic J Benford

**Principal Investigator:**

Peter F Bloser

**Co-Investigators:**

Lisa Scigliano

James M Ryan

Mark Mcconnell

## Technology Areas

**Primary:**

- TX08 Sensors and Instruments
  - └ TX08.1 Remote Sensing Instruments/Sensors
    - └ TX08.1.1 Detectors and Focal Planes

## Target Destination

Outside the Solar System